Malaria Modeling and Surveillance In Thailand and Indonesia

Richard Kiang, Farida Adimi, Radina Soebiyanto
Valerii Soika, Joseph Nigro
NASA Goddard Space Flight Center
Greenbelt, Maryland 20771
USA

In Collaboration With

WHO SEARO
- Dr. Krongthong Thimasarn
- Dr. Ferdinand Laihad
- Dr. Rakesh Rastogi

Thai MOPH
- Dr. Jeeraphat Sirichaisinthop

Tropical Medicine, Mahidol Univ.
- Dr. Pratap Singhasivanon
- Dr. Chamnarn Apiwathnasorn
- Dr. Somjai Leemingsawat
- Dr. Sornchai Looareesuwan

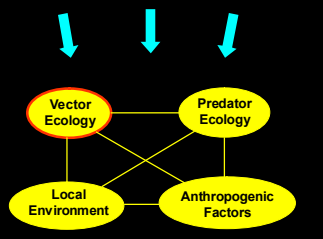
WRAIR
- Dr. Russell Coleman
- Dr. Gabriela Zollner

AFRIMS
- Dr. James Jones *(retired)*
- Dr. Jetsumon Sattabongkot

NDVECC
- Dr. Craig Stoops

USDA APHIS
- Dr. Bimo Wicaksana

Meteorological & Climatological Parameters



AGRICULTURAL PRACTICE
ROAD BUILDING
DEFORESTATION
MILITARY CONFLICT
REFUGEES
ECONOMIC CRISIS
MEDICAL CARE

THE PROBLEM

- 40% of the world's populations at risk
- 300-500 million cases per year
- 1-3 million deaths per year
- Highest risks for children, pregnant women, and people with depressed immunoresponse
- ≈ One death every 30 seconds
- Counterfeit and substandard antimalaril drugs abound.
- ACT is becoming less sensitive.
- Previously unaffected regions may have outbreaks due to climate change.

richard.kiang@nasa.gov

OBJECTIVES

Risk detection
Detection of larval habitats
Textural-contextual classification

Risk prediction
Prediction of current and future endemicity
Neural network methods

Risk reduction
Identification of key factors that sustain or promote transmissions
Agent-based discrete event simulation

BENEFITS

→ Applying larval control as a preventive measure

→ Strengthening and mobilizing public health support

→ Cost-effectively curtailing malaria transmission

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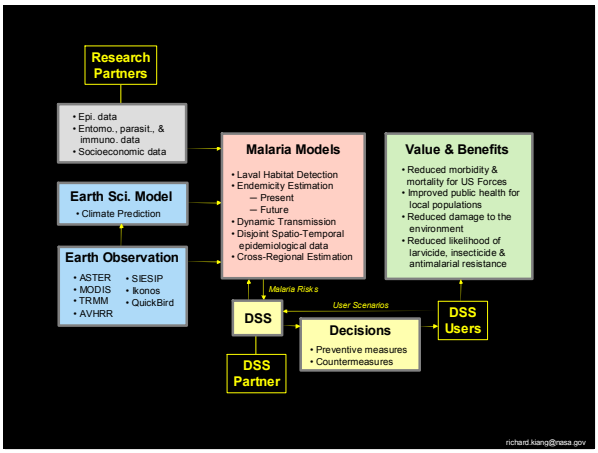
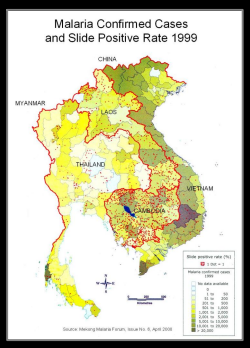


The Greater Mekong Subregion is the world's epicenter of multi-drug resistant falciparum malaria.



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Most Thai provinces endemic with malaria are border provinces.

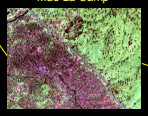
The largest refugee camp in Thailand (with > 30,000 population)

Collecting larvae,

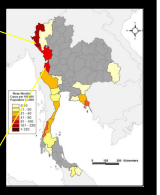
… mosquitoes,

… and blood samples.

Mae La Camp



Kong Mong Tha Test Site



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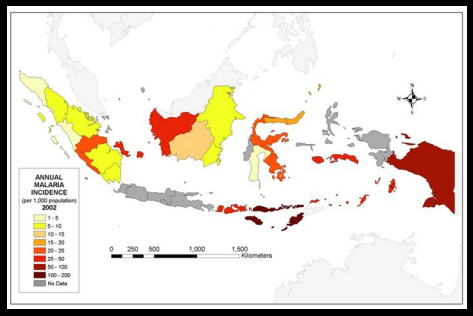
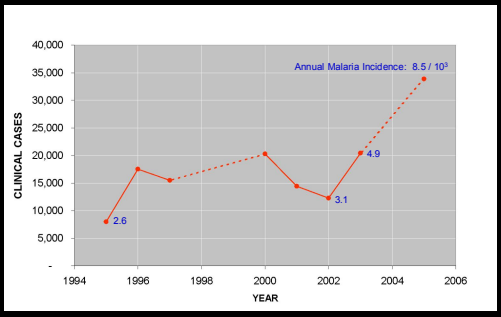
40% of the 245M Indonesians Live in Malarious Regions



Source: WHO SEARO

Malaria Incidence in Aceh Increased Significantly After the Tsunami Disaster in December 2004



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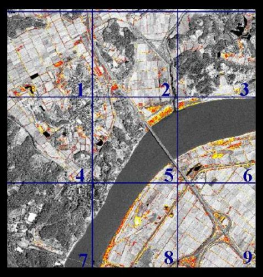
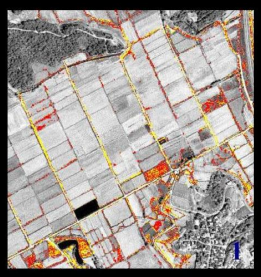
Detection of Ditches using Pan-sharpened Ikonos Data

(Larval Habitats of *Anopheles sinensis* in Korea)





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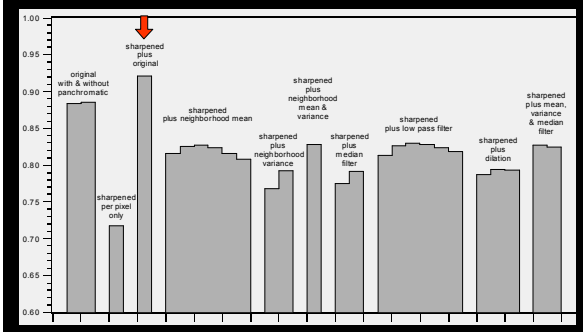
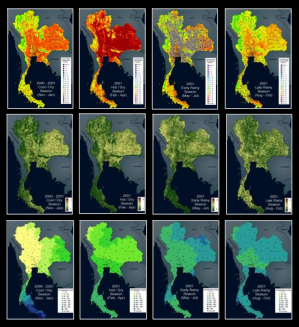
Classification Accuracy using Pan-Sharpened Ikonos Data (1 meter resolution)



Satellite-Observed Meteorological & Environmental Parameters For Four Thailand Seasons



Surface Temperature
MODIS Measurements

Vegetation Index
AVHRR & MODIS Measurements

Rainfall
TRMM Measurements

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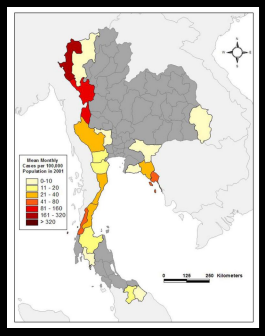
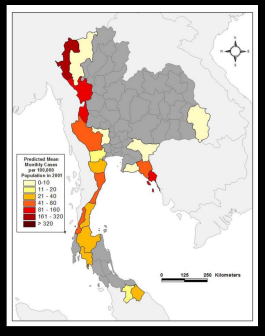
Actual Malaria Incidence



Hindcast Incidence



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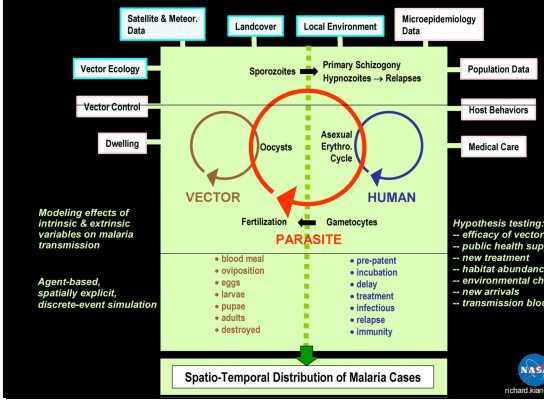
Dynamic Transmission Modeling Framework



Modeling effects of intrinsic & extrinsic variables on malaria transmission

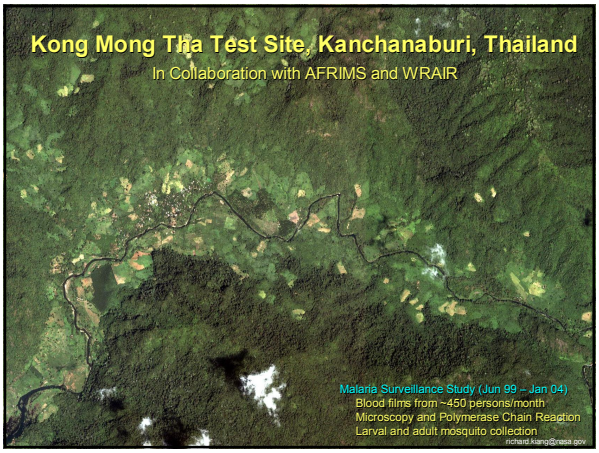
Agent-based, spatially explicit, discrete-event simulation

Hypothesis testing:
-- efficacy of vector control
-- public health support
-- new treatment
-- habitat abundance
-- environmental changes
-- new arrivals
-- transmission blocking

richard.kiang@nasa.gov

Kong Mong Tha Test Site, Kanchanaburi, Thailand

In Collaboration with AFRIMS and WRAIR



Malaria Surveillance Study (Jun 99 – Jan 04)
Blood films from ~450 persons/month
Microscopy and Polymerase Chain Reaction
Larval and adult mosquito collection

richard.kiang@nasa.gov

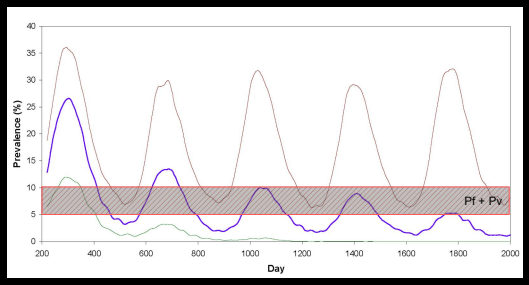
Example: A Small Hamlet

23 houses
2 cattle sheds
24 clusters of larval habitats

69 adults
23 childrens
8 cows

richard.kiang@nasa.gov

Modeled and Observed Prevalence



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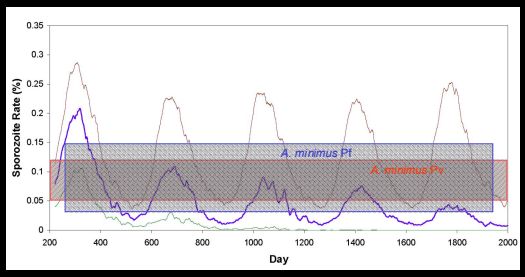
Modeled and Observed Sporozoite Rates



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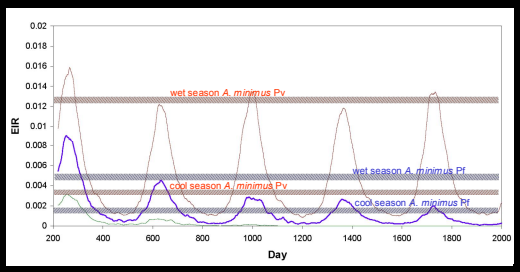
Modeled and Observed Entomological Inoculation Rates

(number of infective bites / person / day)



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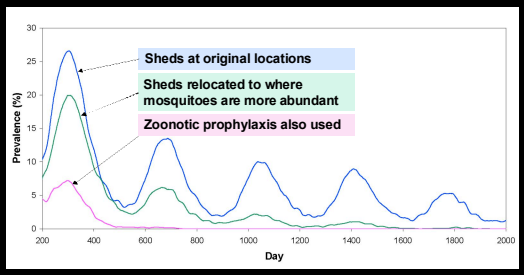
Well Placed Farm Animal Sheds and Zoonotic Prophylaxis May Significantly Reduce Malaria Transmission



richard.kiang@nasa.gov

Sensitivity Studies and Simulations Performed

Using Agent-Based Discrete Event Simulation Model

- Abundance of larval habitats
- Access to health care and appropriate treatment
- Asymptomatic cases
- Acquired immunity
- Active and passive case detections
- Bednets or personal protections
- Improved dwelling construction
- Parasite infectivity in mosquitoes
- Zoonotic prophylaxis
- Arrival of non-immune populations (such as migrant workers, refugees, foreign military forces)

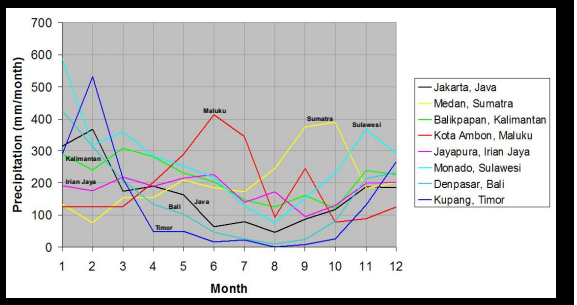
richard.kiang@nasa.gov

With over 18,000 islands and a decentralized government, it is challenging to implement malaria control policy.

richard.kiang@nasa.gov

Rainfall Pattern, Which Drives Malaria Transmission, Varies Significantly from Island to Island

Average Monthly Precipitation for the Major Cities on the 8 Islands 2000-2005



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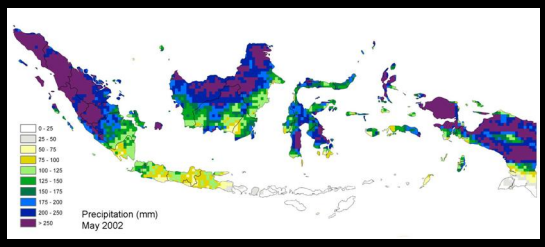
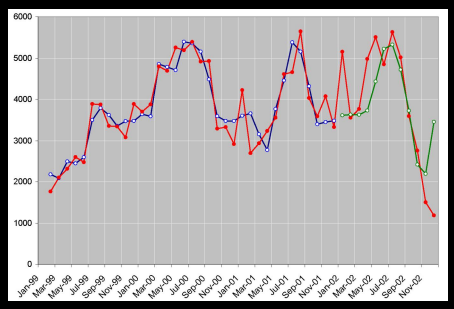
Precipitation Based on TRMM Measurements



richard.kiang@nasa.gov

Hindcasting Malaria Cases in Jawa Tengah, Indonesia

Actual (red), Modeled (blue), and Hindcast (green) Malaria Cases



richard.kiang@nasa.gov

Districts Involved in Menoreh Hills Project

– A MOH-WHO-NAMRU2-USAID Collaboration

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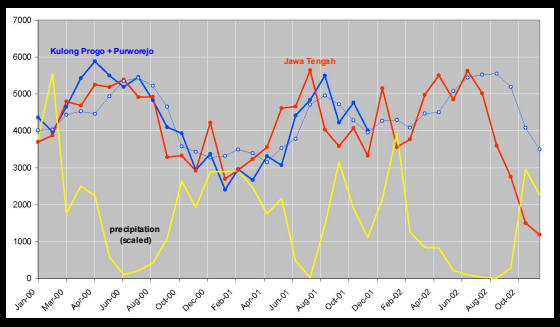
Comparison of Kulong Progo and Purworejo ACD Cases (blue) with Jawa Tengah PCD Cases (red)



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Thank you!
richard.kiang@nasa.gov